Evaluation of Additively-Manufactured, Consumable Structure Options for Small Spacecraft Propulsion Systems

Completed Technology Project (2016 - 2018)

Project Introduction

A propulsion system for small spacecraft is proposed that will be partially contained in the spacecraft structure. The preliminary design will fit into a 3-Unit (U) sized CubeSat with the payload occupying 1-U and the propulsion system occupying the remaining space. The structure of the 2-U section will be partially comprised of four additively-manufactured acrylonitrile butadiene styrene (ABS) fueled hybrid rocket motors. Additively manufacturing the ABS fuel grains serves two purposes. One, it allows the fuel grains to be 3D printed within the overall spacecraft structure, thereby replacing structural mass with usable fuel. Once the fuel has been exhausted, a portion of the structure will remain to ensure the spacecraft structure continues to be sound. Second, unlike extruded ABS, 3D printed ABS possesses the capability to produce electrical arc ignition when a voltage is sent through electrodes embedded in the fuel grain. Such ignition coupled with the hybrid rocket motor's throttling abilities results in a reliably restartable propulsive system. Since the hybrid motor fuel and oxidizer are stored separately, there is also no chance of accidental ignition. A safe, reliable, restartable propulsion system is desirable for small spacecraft that must participate in rideshares to reach orbit. Once placed in orbit, the spacecraft must rely on on-board propulsion for attitude and orbit control. The proposed partially-consumable structure will increase the safety and efficiency of small spacecraft propulsion compared to currently available hydrazine systems. This is significant for small spacecraft endeavors because rideshares are more likely to accept spacecraft that contain non-hazardous propulsive fuels that will not accidentally ignite. Additionally, an on-board propulsion system with restart capabilities will grant small spacecraft missions the ability to pursue a wider range of mission objectives. The proposed mass-reducing and safety- and efficiency-increasing propulsion system is an innovative enhancement for the growing small spacecraft industry.

Anticipated Benefits

The proposed partially-consumable structure will increase the safety and efficiency of small spacecraft propulsion compared to currently available hydrazine systems. This is significant for small spacecraft endeavors because rideshares are more likely to accept spacecraft that contain non-hazardous propulsive fuels that will not accidentally ignite. Additionally, an on-board propulsion system with restart capabilities will grant small spacecraft missions the ability to pursue a wider range of mission objectives. The proposed mass-reducing and safety- and efficiency-increasing propulsion system is an innovative enhancement for the growing small spacecraft industry.

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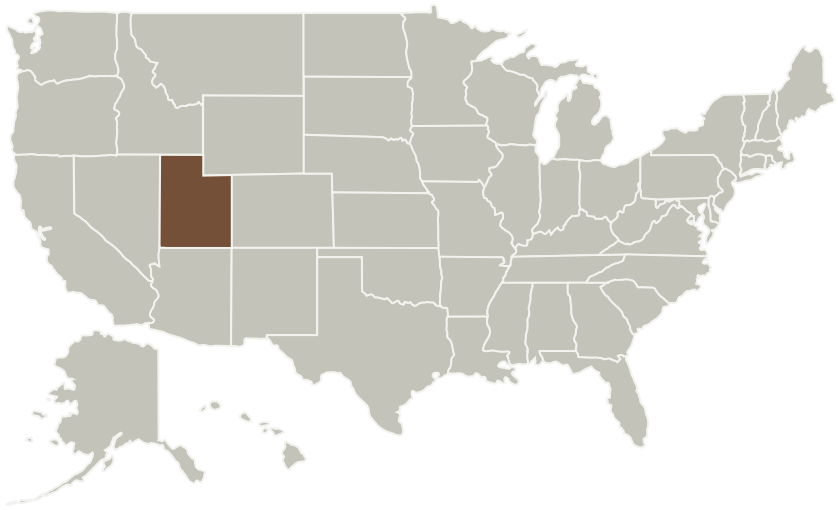
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Utah State University(USU)	Lead Organization	Academia Alaska Native and Native Hawaiian Serving Institutions (ANNH)	Logan, Utah

Primary U.S. Work Locations
Utah

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Utah State University (USU)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Stephen A Whitmore

Co-Investigator:

Britany Chamberlain

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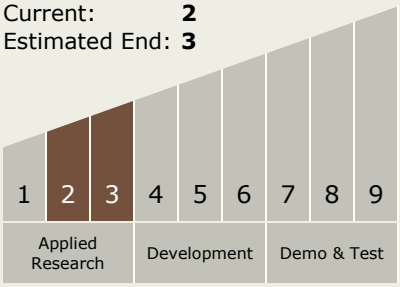
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.5 Hybrids

Target Destination

Earth